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CLINICAL ARTICLE

Do obese patients undergoing surgery for grade 1 spondylolisthesis have worse outcomes at 5 years' follow-up? A QOD study

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OBJECTIVE The long-term effects of increased body mass index (BMI) on surgical outcomes are unknown for patients who undergo surgery for low-grade lumbar spondylolisthesis. The goal of this study was to assess long-term outcomes in obese versus nonobese patients after surgery for grade 1 spondylolisthesis.

METHODS Patients who underwent surgery for grade 1 spondylolisthesis at the Quality Outcomes Database's 12 highest enrolling sites (SpineCORe group) were identified. Long-term (5-year) outcomes were compared for patients with BMI ≥ 35 versus BMI < 35.

RESULTS In total, 608 patients (57.6% female) were included. Follow-up was 81% (excluding patients who had died) at 5 years. The BMI ≥ 35 cohort (130 patients, 21.4%) was compared to the BMI < 35 cohort (478 patients, 78.6%). At baseline, patients with BMI ≥ 35 were more likely to be younger (58.5 ± 11.4 vs 63.2 ± 12.0 years old, $p < 0.001$), to present with both back and leg pain (53.8% vs 37.0%, $p = 0.002$), and to require ambulation assistance (20.8% vs 9.2%, $p < 0.001$). Furthermore, the cohort with BMI ≥ 35 had worse baseline patient-reported outcomes including visual analog scale (VAS) back (7.6 ± 2.3 vs 6.5 ± 2.8, $p < 0.001$) and leg (7.1 ± 2.6 vs 6.4 ± 2.9, $p = 0.031$) pain, disability measured by the Oswestry Disability Index (ODI) (53.7 ± 15.7 vs 44.8 ± 17.0, $p < 0.001$), and quality of life on EuroQol-5D (EQ-5D) questionnaire (0.47 ± 0.22 vs 0.56 ± 0.22, $p < 0.001$). Patients with BMI ≥ 35 were more likely to undergo fusion (85.4% vs 74.7%, $p = 0.01$). There were no significant differences in 30- and 90-day readmission rates ($p > 0.05$).

Five years postoperatively, there were no differences in reoperation rates or the development of adjacent-segment disease for patients in either BMI < 35 or ≥ 35 cohorts who underwent fusion ($p > 0.05$). On multivariate analysis, BMI ≥ 35 was a significant risk factor for not achieving minimal clinically important differences (MCIDs) for VAS leg pain (OR

ABBREVIATIONS ASA = American Society of Anesthesiologists; BMI = body mass index; EQ-5D = EuroQol-5D; MCID = minimal clinically important difference; MIS = minimally invasive surgery; NASS = North American Spine Society; ODI = Oswestry Disability Index; PRO = patient-reported outcome; QOD = Quality Outcomes Database; TLIF = transforaminal lumbar interbody fusion; VAS = visual analog scale.

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0.429, 95% CI 0.209–0.876, p = 0.020), but BMI ≥ 35 was not a predictor for achieving MCID for VAS back pain, ODI, or EQ-5D at 5 years postoperatively.

CONCLUSIONS Both obese and nonobese patients benefit from surgery for grade 1 spondylolisthesis. At the 5-year time point, patients with BMI ≥ 35 have similarly low reoperation rates and achieve rates of satisfaction and MCID for back pain (but not leg pain), disability (ODI), and quality of life (EQ-5D) that are similar to those in patients with a BMI < 35.

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KEYWORDS low-grade spondylolisthesis; obesity; patient-reported outcomes; degenerative

Obesity is a global health concern with a rapidly increasing prevalence that poses numerous challenges across various medical disciplines, including spine surgery.[1] One of the most complex areas in which obesity introduces complications is in surgeries for conditions like low-grade spondylolisthesis. Spine surgery in obese patients is suggested to have longer operative times, increased blood loss, and a higher rate of postoperative complications.[2–8] A critical aspect of this challenge arises from the biomechanical alterations due to the excess weight obese patients bear. This increased mechanical load, coupled with metabolic changes, may predispose these patients to both intraoperative and postoperative complications.[3]

These complications are not merely procedural. From a patient outcome perspective, the biomechanical strain due to obesity can exacerbate postoperative pain.[9] Djurasovic et al. reported that while both obese and nonobese patients reported significant improvements in pain and disability measures at the 2-year follow-up postsurgery, nonobese patients exhibited better patient-reported outcomes (PROs).[33] This disparity was particularly pronounced in the SF-36 physical component summary and Oswestry Disability Index (ODI) scores, in which nonobese patients outperformed their obese counterparts. Moreover, obese patients encountered elevated complication rates, predominantly related to wound-related concerns.[33]

Extending the postoperative time line further, Rihn et al. reported that obese patients had a doubled reoperation rate at the 4-year follow-up.[10] Furthermore, whereas the primary outcome measures were comparable between obese and nonobese patients at this juncture, the SF-36 physical function score showed less improvement in the obese cohort.[10] Moreover, Krüger et al. demonstrated a concerning trend in patient outcomes based on body mass index (BMI).[34] The cohort with high BMI had a higher likelihood of unfavorable outcomes.

Previous studies have not investigated the long-term effect of obesity on surgical outcomes. To the best of our knowledge, this is the only study to compare the long-term (up to 5 years) postoperative outcome of patients who underwent surgery for treatment of grade 1 spondylolisthesis, with and without obesity. A cutoff of at least class 2 obesity (BMI ≥ 35) was selected because the prevalence of this level of obesity has been increasing worldwide in recent years, and class 2 obesity is a known risk factor for poor outcomes in many medical pathologies.[11–13]

Methods

This prospective study used an augmented dataset, from the Quality Outcomes Database (QOD) Lumbar module.[14] Twelve high-enrolling sites of the QOD Lumbar module collected and combined their data (SpineCORe group) with a high follow-up rate at 5 years. Included data were audited by site-specific teams as well as a central team. Inclusion criteria in this dataset have been extensively described previously.[14,15] Adult patients (≥ 18 years old) who underwent elective surgery between July 2014 and June 2016 were included if preoperative imaging confirmed a Meyerding classification of grade 1 spondylolisthesis.[16] Eligible surgeries included single-level disc decompression or vertebral fusion across one disc space. Patients were not eligible if they were found to have grade 2 or higher spondylolisthesis, spinal neoplasm, infection, deformity, traumatic dislocation, or neurological paralysis secondary to preexisting spine pathology.

Demographic and Perioperative Characteristics

The QOD registry collects demographic information (including age, sex, BMI, ethnicity, insurance, and employment) as well as clinical characteristics (including comorbidities, American Society of Anesthesiologists [ASA] Physical Status Classification System, dominant presenting symptom, ambulation status, and symptom duration) for all enrolled patients. Furthermore, preoperative PRO data are collected, including visual analog scale (VAS) back and leg pain, back pain–related disability measured by the ODI, and quality of life measured by the EuroQol-5D (EQ-5D) questionnaire.[17] In addition, the level of spondylolisthesis, millimeters of listhesis measured using standing lateral radiographic films, and the presence of dynamic spondylolisthesis are noted using flexion-extension radiographs. Surgical and perioperative characteristics such as fusion status, approach (anterior vs posterior vs lateral vs staged), estimated blood loss, and discharge disposition are also recorded for each patient.

Postoperative Outcomes

Five-year follow-up postoperative outcomes data were collected for the study cohort, including reoperations related to initial surgery for grade 1 spondylolisthesis, reoperations for adjacent-segment disease (for patients who underwent fusion), VAS back and leg pain scores, and ODI. The mean preoperative to postoperative change (postoperative score – preoperative score) for each of the aforementioned PROs was calculated to ascertain if minimal clinically important differences (MCIDs) were achieved. An MCID was defined as an improvement of 14.3 points for ODI, 0.2 points for EQ-5D, 1.7 points for VAS leg pain, and 1.6 points for VAS back pain.[18] Furthermore, patient satisfaction at the 5-year time point postoperatively was assessed using the North American Spine Society (NASS) Patient Satisfaction Index. The NASS questionnaire eval-

uates satisfaction by using a scale ranging from 1 ("the treatment met my expectations") to 4 ("I am the same or worse than before treatment").[19]

Study Design and Statistical Analysis

In this study, patients undergoing surgery who had class 2 obesity or greater (BMI ≥ 35) were compared to those with BMI < 35. Variables compared include the demographic and perioperative characteristics as well as the postoperative outcomes described above. Analysis was conducted using the Student t-test and the chi-square test (Yates's correction used if expected values in chi-square contingency were < 5) for continuous and categorical variables, respectively. Separate multivariate logistic regression models were trained for each PRO (i.e., VAS back, VAS leg, disability [ODI], and quality of life [EQ-5D])—controlling for variables in Table 1 that had p values < 0.2, for each PRO's baseline values, and for fusion versus decompression status.

Results

In total, 608 patients (57.6% female) who underwent surgery for grade 1 spondylolisthesis were identified. The study cohort contained 130 (21.4%) patients with BMI ≥ 35 and 478 (78.6%) patients with BMI < 35 (nonobese cohort). All outcome variables had at least 80% follow-up at 5 years postoperatively.

There were no differences between the two cohorts in terms of gender distribution, preoperative smoking status, presence of motor deficit, or symptom duration. When comparing preexisting comorbidities between cohorts, there were no significant differences in terms of the rates of coronary artery disease, anxiety, or osteoporosis. There were no significant differences in terms of ethnicity (Hispanic), employment status, or private insurance usage ($p > 0.05$) (Table 1).

At baseline, patients with BMI ≥ 35 were younger at the time of surgery (58.5 ± 11.4 vs 63.2 ± 12.0, $p < 0.001$); more likely to present with both back and leg pain (53.8% vs 37.0%, $p = 0.002$); and required assistance for ambulation (20.8% vs 9.2%, $p < 0.001$). The BMI ≥ 35 cohort had significantly higher rates of diabetes (31.5% vs 12.6%, $p < 0.001$) and depression (27.7% vs 18.2%, $p = 0.017$), as well as increased frequency of ASA grades > 2 ($p < 0.001$). The BMI ≥ 35 cohort had fewer college or higher graduate degrees (27.3% vs 41.7%, $p = 0.003$). When comparing baseline PROs, patients with BMI ≥ 35 had worse VAS back (7.6 ± 2.3 vs 6.5 ± 2.8, $p < 0.001$) and leg (7.1 ± 2.6 vs 6.4 ± 2.9, $p = 0.031$) pain scores, disability measured by ODI (53.7 ± 15.7 vs 44.8 ± 17.0, $p < 0.001$), and quality of life measured by EQ-5D (0.47 ± 0.22 vs 0.56 ± 0.22, $p < 0.001$). There were no significant differences in the level of spondylolisthesis between the cohorts with BMI ≥ 35 and BMI < 35; there were similar rates of L3–4 (8.5% vs 9.0%), L4–5 (71.5% vs 66.5%), and L5–S1 (17.7% vs 21.8%) spondylolisthesis ($p = 0.781$). Similarly, there were no differences in the millimeters of listhesis (6.7 ± 3.8 vs 6.5 ± 3.9 mm, $p = 0.654$) and rate of dynamic spondylolisthesis (41.4% vs 30.5%, $p = 0.116$) between obese and nonobese patients (Table 1).

Perioperatively, although there were no differences in surgical approach (anterior vs posterior vs lateral vs 2-staged) between the cohorts, the BMI ≥ 35 cohort was more likely to undergo fusion (85.4% vs 74.7%, $p = 0.01$). There were no significant differences in patients who underwent minimally invasive surgery (MIS) transforaminal lumbar interbody fusion (TLIF) between the obese and nonobese cohort (6.9% vs 13.2%, $p = 0.05$). The perioperative course of the cohort with BMI ≥ 35 was complicated by increased mean surgical blood loss (262.9 ± 259.6 vs 165.5 ± 175.8 ml, $p < 0.001$), lengths of surgery (195.4 ± 84.7 vs 170.7 ± 85.0, $p = 0.004$) and hospitalization (3.2 ± 1.5 vs 2.6 ± 1.8 days, $p < 0.001$), and rates of nonroutine/nonhome discharge (17.1% vs 7.4%, $p < 0.001$). However, subgroup analysis of patients who underwent arthrodesis only demonstrated that although patients with BMI ≥ 35 had higher blood loss (288.7 ± 268.6 vs 204.9 ± 182.2 ml), the two cohorts did not differ in terms of surgical time and hospitalization lengths ($p > 0.05$). There were no significant differences in 30- and 90-day readmission rates (Table 2).

At the 5-year postoperative interval, 35 patients had died (26 in the BMI < 35 cohort, 9 in the BMI ≥ 35 group) and were not included in the outcomes analyses. There were no significant differences between the BMI ≥ 35 and BMI < 35 cohorts in 5-year reoperations related to the index surgery (10.5% vs 13.1%, $p = 0.477$), as well as reoperations specifically for adjacent-segment disease among patients who underwent fusion (4.3% vs 5.9%, $p = 0.546$). The BMI ≥ 35 cohort reported significantly worse PROs including VAS back (4.3 ± 3.3 vs 3.3 ± 3.0, $p = 0.003$) and leg (3.7 ± 3.4 vs 2.3 ± 2.9, $p < 0.001$), disability (ODI 33.0 ± 21.2 vs 21.5 ± 19.0, $p < 0.001$), and quality of life (EQ-5D: 0.66 ± 0.25 vs 0.76 ± 0.22, $p < 0.001$). Furthermore, the BMI ≥ 35 cohort achieved lower rates of MCID for VAS leg pain (58.6% vs 72.9%, $p = 0.006$). However, both the BMI ≥ 35 and the BMI < 35 cohorts experienced similar rates of achieving MCID for VAS back pain, back pain–related disability (ODI scale), and quality of life (EQ-5D) ($p > 0.05$). Importantly, both cohorts expressed similar rates of satisfaction regarding the surgery they underwent ($p = 0.083$) (Table 3).

On multivariate analysis, BMI ≥ 35 was not a significant predictor of achieving MCID for VAS back pain, disability measured by ODI, and quality of life measured by the EQ-5D questionnaire ($p > 0.05$). However, BMI ≥ 35 was a significant risk factor for not achieving MCID for VAS leg pain (OR 0.429, 95% CI 0.209–0.876, $p = 0.020$) (Table 4).

Discussion

The relationship between patient-specific factors, notably BMI, and the outcomes after lumbar spine surgery has increasingly become a focal point of clinical research, and our recent study further underscores its significance. Our findings elucidate that patients with a BMI ≥ 35 typically present for surgery at a relatively younger age and more commonly experience both back and leg pain. Moreover, these patients were more frequently observed to require assistance with ambulation. Their baseline metrics, when juxtaposed against their counterparts with a lower BMI, pointed to significantly worse PROs at 5 years after sur-

TABLE 1. Baseline characteristics of patients with BMI < 35 compared to those with BMI ≥ 35

Variable	BMI <35, n = 478	BMI ≥35, n = 130	p Value
Age, mean ± SD	63.2 ± 12.0	58.5 ± 11.4	**<0.001**
Female (%)	272 (56.9%)	78 (60.0%)	0.527
BMI, mean ± SD	27.9 ± 3.8	39.8 ± 4.7	**<0.001**
Smoker (%), n = 602	58/473 (12.3%)	13/129 (10.1%)	0.495
Comorbidities			
Diabetes (%)	60 (12.6%)	41 (31.5%)	**<0.001**
Coronary artery disease (%)	53 (11.1%)	15 (11.5%)	0.885
Anxiety (%)	79 (16.5%)	29 (22.3%)	0.126
Depression (%)	87 (18.2%)	36 (27.7%)	**0.017**
Osteoporosis (%)	34 (7.1%)	4 (3.1%)	0.092
Dominant symptom			**0.002**
Back pain dominant (%)	190 (39.7%)	40 (30.8%)	
Leg pain dominant (%)	111 (23.2%)	20 (15.4%)	
Equal back & leg pain (%)	177 (37.0%)	70 (53.8%)	
Motor deficit present (%), n = 607	112/477 (23.5%)	27 (20.8%)	0.514
Dependent ambulation	44 (9.2%)	27 (20.8%)	**<0.001**
Symptom duration, n = 586			0.419
<3 mos (%)	13/458 (2.8%)	2/128 (1.6%)	
≥3 mos (%)	445/458 (97.2%)	126/128 (98.4%)	
ASA grade, n = 583			**<0.001**
1 (%)	21/460 (4.6%)	2/123 (1.6%)	
2 (%)	290/460 (63.0%)	33/123 (26.8%)	
3 (%)	146/460 (31.7%)	85/123 (69.1%)	
4 (%)	3/460 (0.7%)	3/123 (2.4%)	
Hispanic ethnicity (%), n = 589	22/464 (4.7%)	7/125 (5.6%)	0.711
College degree or higher (%), n = 593	194/465 (41.7%)	35/128 (27.3%)	**0.003**
Employed (%), n = 604	215/474 (45.4%)	60 (46.2%)	0.872
Private insurance (%)	243 (50.8%)	76 (58.5%)	0.123
Baseline VAS back pain, mean ± SD, n = 546	6.5 ± 2.8	7.6 ± 2.3	**<0.001**
Baseline VAS leg pain, mean ± SD, n = 600	6.4 ± 2.9	7.1 ± 2.6	**0.031**
Baseline ODI, mean ± SD, n = 602	44.8 ± 17.0	53.7 ± 15.7	**<0.001**
Baseline EQ-5D, mean ± SD, n = 546	0.56 ± 0.22	0.47 ± 0.22	**<0.001**
Level of spondylolisthesis			0.781
L3–4 (%)	43 (9.0%)	11 (8.5%)	
L4–5 (%)	318 (66.5%)	93 (71.5%)	
L5–S1 (%)	104 (21.8%)	23 (17.7%)	
Multilevel (%)	2 (0.4%)	1 (0.8%)	
Other lumbar level (%)	11 (2.3%)	2 (1.5%)	
Listhesis in mm, mean ± SD, n = 391	6.5 ± 3.9	6.7 ± 3.8	0.654
Dynamic spondylolisthesis (%), n = 281	68/223 (30.5%)	24/58 (41.4%)	0.116

Boldface type indicates statistical significance.

gery. Their perioperative outcomes were associated with challenges such as increased blood loss, increase in hospital length of stay, and increased rates of nonhome discharges. These outcomes resonate with and reinforce prior research, stressing the consequential role that class 2 obesity (BMI ≥ 35) plays in the realm of spine surgery (Tables 1–3).

The observations in this study corroborate the literature. For instance, De la Garza Ramos et al. and Nakajima et al. both highlighted that obese patients (BMI ≥ 30) had exacerbated symptoms postsurgery and faced a reduced likelihood of achieving substantial pain relief.[20,21] This offers a compelling indication that while the surgical intervention aims to ameliorate pain and improve overall quality of life, the preexisting factor of obesity can act as an impediment to these intended outcomes.

The national QOD has been an invaluable resource in

TABLE 2. Surgical and perioperative comparison of patients with BMI < 35 and BMI ≥ 35

Variable	BMI <35, n = 478	BMI ≥35, n = 130	p Value
Surgical approach, n = 607			0.876
Posterior (%)	438 (91.6%)	121/129 (93.8%)	
Anterior (%)	14 (2.9%)	3/129 (2.3%)	
Lateral (%)	6 (1.3%)	1/129 (0.8%)	
Staged (%)	20 (4.2%)	4/129 (3.1%)	
Arthrodesis performed (%)	357 (74.7%)	111 (85.4%)	**0.01**
Estimated blood loss in ml, mean ± SD			
Entire study cohort, n = 590	165.5 ± 175.8	262.9 ± 259.6	**<0.001**
Fusion-only cohort, n = 454	204.9 ± 182.2	288.7 ± 268.6	**<0.001**
Length of surgery in mins, mean ± SD, n = 581			
Entire study cohort, n = 581	170.7 ± 85.0	195.4 ± 84.7	**0.004**
Fusion-only cohort, n = 464	189.4 ± 83.3	205.5 ± 80.8	0.074
Hospitalization length in days, mean ± SD			
Entire study cohort, n = 608	2.6 ± 1.8	3.2 ± 1.5	**<0.001**
Fusion-only cohort, n = 468	3.1 ± 1.7	3.4 ± 1.4	0.146
Discharge disposition, n = 605			**<0.001**
Home or home healthcare (%)	441/476 (92.6%)	107/129 (82.9%)	
Other (%)	35/476 (7.4%)	22/129 (17.1%)	
30-day readmissions (%)	9 (1.9%)	2 (1.5%)	>0.99
90-day readmissions (%)	15 (3.1%)	8 (6.2%)	0.181

Boldface type indicates statistical significance.

TABLE 3. Outcomes 5 years postoperatively in patients with BMI ≥ 35 compared to those with BMI < 35

Variable	BMI <35, n = 452*	BMI ≥35, n = 121*	p Value
Reoperations			
Related to original surgery (%), n = 472	48/367 (13.1%)	11/105 (10.5%)	0.477
Adjacent-segment disease (%), n = 396†	18/297 (6.1%)	4/91 (4.4%)	0.548
VAS back pain			
5-yr score, mean ± SD, n = 465	3.3 ± 3.0	4.3 ± 3.3	**0.003**
MCID VAS back pain (%), n = 421	226/341 (66.3%)	53/80 (66.3%)	0.997
VAS leg pain			
5-yr score, mean ± SD, n = 463	2.3 ± 2.9	3.7 ± 3.4	**<0.001**
MCID VAS leg pain (%), n = 460	263/361 (72.9%)	58/99 (58.6%)	**0.006**
ODI			
5-yr score, mean ± SD, n = 484	21.5 ± 19.0	33.0 ± 21.2	**<0.001**
MCID ODI (%), n = 480	242/377 (64.2%)	59/103 (57.3%)	0.199
EQ-5D			
5-yr score, mean ± SD, n = 463	0.76 ± 0.22	0.66 ± 0.25	**<0.001**
MCID VAS leg pain (%), n = 460	170/361 (47.1%)	44/99 (44.4%)	0.64
Satisfaction; NASS score, n = 465			0.083
1	263/370 (71.1%)	56/95 (58.9%)	
2	54/370 (14.6%)	16/95 (16.8%)	
3	19/370 (5.1%)	7/95 (7.4%)	
4	34/370 (9.2%)	16/95 (16.8%)	

We found no differences in reoperation rates, and patients achieved equivalent rates of MCID for VAS back pain, ODI, EQ-5D, and overall satisfaction scores. Boldface type indicates statistical significance.

* Excluding 26 patients from the BMI < 35 cohort and 9 patients from the BMI ≥ 35 cohort who were dead at follow-up.

† Denominator reflects 396 patients who underwent fusion and had follow-up at 5 years.

TABLE 4. Multivariate analysis for odds of achieving MCID for ODI, VAS back pain, and VAS leg pain for patients with BMI ≥ 35 after controlling for confounding variables

	OR (BMI ≥35)	95% CI	p Value
MCID VAS back pain	0.913	0.473–1.788	0.789
MCID VAS leg pain	0.429	0.209–0.876	**0.020**
MCID ODI	0.987	0.527–1.867	0.967
MCID EQ-5D	0.778	0.368–1.632	0.507

Boldface type indicates statistical significance.

assessing and understanding the multifaceted impacts of lumbar spine surgery.[22] A recent study derived from the QOD's SpineCORe team has underlined the significance of patient demographics, clinical characteristics, and even psychosocial factors on the outcomes. Notably, this study focused on the impact of demographic and clinical aspects on the MCID for ODI postsurgery and found that conventional parameters such as patient age, gender, baseline pain, and even smoking status were not consequential in the achievement of the desired ODI outcome over a 2-year span.[2] Interestingly, the presence of a depressive or anxiety disorder at the time of enrollment also did not influence achievement of the ODI goal. However, a higher BMI and a higher ODI at baseline were linked to lower odds of reaching the ODI goal, with ORs of 0.95 (95% CI 0.91–0.98, p = 0.003) and 0.96 (95% CI 0.95–0.98, p < 0.001) respectively. In another QOD study that focused on women's PROs after undergoing surgery for grade 1 degenerative lumbar spondylolisthesis, patients with lower BMI reported significantly higher satisfaction 12 months after surgery compared to patients with higher BMI.[4] Our study shows that obese patients are likely to continue to have similar outcomes at the 5-year mark postoperatively. Similar studies have also shown that an increase in BMI was an independent predictor of achieving MCID in ODI and MCID in EQ-5D at 2-year postoperative follow-up.[18,23] Another QOD project studied 282 patients with low-grade spondylolisthesis who had a preoperative BMI ≥ 30. Using a machine learning algorithm, the study revealed that a preoperative BMI threshold of 37.5 kg/m^2 or lower was associated with improved outcomes 1 year after surgery, including less pain, better quality of life, and greater satisfaction.[8]

A QOD study aimed at understanding the influence of BMI on sexual function postoperatively revealed that patients with grade 1 spondylolisthesis who presented with increased BMI consistently reported less improvement in their sex life following surgery.[24] This is a vital consideration, as sexual well-being is an integral component of overall quality of life. Specifically, for patients younger than 57 years, a lower BMI was the only determining factor for improved sexual function. However, for those 57 years and older, apart from BMI, other factors came into play, including the patient's ASA grade and their educational background. These multidimensional findings suggest that BMI is undeniably a significant factor in determining postoperative sexual well-being and patient satisfaction, particularly in the young population.[24]

Patient factors like BMI and smoking status have also been shown to accurately predict patient postoperative outcomes including the length of stay.[7] Our study showed that obese patients were more likely to have increased blood loss during surgery and a longer hospital stay. These two perioperative outcomes were shown to be associated with worse PROs.[25] These findings suggest that the surgical approach also garners attention in the context of patient outcomes. MIS has been shown to be associated with reduced blood loss and shorter hospital stays compared to conventional open surgery.[26,27] Given these benefits, MIS could be particularly beneficial for obese patients who often face longer recovery periods and are at a higher risk of complications.

Another pivotal observation derived from our study aligns with findings from Devin et al., which established that an elevation in BMI directly correlated with a decreased likelihood of significant postoperative improvements and overall patient satisfaction.[6] This consistent observation across multiple studies solidifies the claim that increased BMI presents substantial challenges in achieving optimal postoperative outcomes.

Our study showed similar results to a recent investigation that aimed to understand factors leading to nonroutine discharges after surgery for grade 1 spondylolisthesis. From a sample of 608 patients, 9.4% experienced nonroutine discharges. Specifically, higher BMI was found to be an independent factor associated with an increased likelihood of nonroutine discharge (interquartile OR 2.04, 95% CI 1.31–3.25, p < 0.001). Other influential factors included older age, the presence of depression, and experiencing any complications postsurgery.[28]

Furthermore, a study by Chan et al. resonates with our observations.[5] In their exploration of the effects of obesity on PROs postsurgery for grade 1 degenerative lumbar spondylolisthesis, they found that although obese patients reported worse baselines for various metrics, by the 12-month mark postsurgery, significant improvements were still noticeable.[5] This suggests that even though the journey might be more challenging for obese patients, significant postoperative improvements are still attainable. We found that patients with BMI ≥ 35 presented with worse †reoperative PROs than patients with BMI < 35; however, both groups had similar rates of achieving MCID for VAS back pain, quality of life (EQ-5D), and back pain–related disability (ODI) at 5 years on univariate and multivariate analysis (Tables 3 and 4). Whereas the multivariate analysis found that BMI ≥ 35 results in lower odds of achieving MCID for leg pain (OR 0.429, 95% CI 0.209–0.876, p = 0.020) at 5 years postoperatively, the BMI ≥ 35 group endorsed satisfaction with surgery equivalent to their BMI < 35 counterparts 5 years after surgery (Table 3). Therefore, it is important to note that obese patients are still valid candidates for surgery for grade 1 spondylolisthesis, given that surgery has been shown to significantly improve PROs.[29]

Limitations

The present research, despite providing valuable insights into the intricate relationship between BMI and postoperative outcomes in grade 1 spondylolisthesis surgeries, has limitations. Although the QOD is prospectively collected, this investigation was not a prospective, randomized study.

Consequently, potential biases in patient and surgical approach selection of the treating physicians become a challenge to address. Without the structured framework of randomization, the study is vulnerable to unknown confounders that might skew the results. Furthermore, although the QOD serves as a powerful tool for studying outcomes of spine surgery, we do not have granular detail on surgical decision-making and the presence of sacroiliac arthritis and facet arthritis, which are known to affect back pain levels.[30] Furthermore, only 64.3% of patients had the necessary radiographs available to measure the millimeters of listhesis. Moreover, even though some studies have discussed the superiority of MIS TLIFs for obese patients, we are unable to comment on this because only 6.9% of surgeries for our study's obese cohort involved MIS TLIFs.[31,32] Additionally, although BMI serves as a standard measure to determine obesity, its accuracy is contestable in certain scenarios. For instance, a person possessing a higher muscle mass might display a high BMI but wouldn't traditionally be classified as obese. Such discrepancies highlight the complexities involved in evaluating outcomes based solely on BMI and underscore the importance of considering other factors.

Conclusions

This is the first study to delve into the 5-year postoperative PROs for patients with class 2 obesity (BMI ≥ 35) undergoing surgery for grade 1 spondylolisthesis. Our results reveal that both obese and nonobese patients benefit from surgery for grade 1 spondylolisthesis. There were no significant differences between patients with BMI ≥ 35 compared to those with BMI < 35 in 5-year reoperation rates; furthermore, there were no differences in the rate of adjacent-segment disease among patients who underwent fusion procedures. Patients with BMI ≥ 35, compared to their BMI < 35 counterparts, achieved similar rates of MCID back pain, disability (ODI), and quality of life (EQ-5D), although they experienced lower rates of achieving MCID for leg pain. Obese patients with grade 1 spondylolisthesis have similar rates of satisfaction compared to nonobese patients and should be considered for surgery.

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Dr. Coric reported personal fees from Spine Wave, Medtronic, Globus Medical, and Premia Spine outside the submitted work. Dr. Potts reported royalty/consulting from Medtronic outside the submitted work. Dr. Bisson reported personal fees from Stryker, Medtronic, and MiRus; nonfinancial support (stock) from nView, Proprio, and SeeAll outside the submitted work. Dr. Fu reported personal fees from Bioventus, DePuy, and ATEC outside the submitted work. Dr. Foley reported royalties, consulting, and stock ownership from Medtronic; stock ownership from Discgenics, DuraStat, NuVasive, RevBio, Spine Wave, Vori Health, and Curetiva outside the submitted work. In addition, Dr. Foley had multiple patents for Medtronic with royalties paid. Dr. Chou reported personal fees from Globus, Orthofix, and Medtronic outside the submitted work. Dr. Meyer reported personal fees from Globus outside the submitted work. Dr. Asher reported personal fees from Globus outside the submitted work. Dr. C. Shaffrey reported nonfinancial support from NuVasive/Globus, Medtronic, SI Bone, and Proprio outside the submitted work. Dr. Wang reported personal fees from DePuy Synthes, Stryker, Spineology, Pacira, and NuVasive; purchased stock from ISD, Kinesiometrics, and Medical Device Partners during the conduct of the study; in addition, Dr. Wang had a patent for DePuy Synthes with royalties paid. Dr. Glassman reported consulting fees from the following: K2M/Stryker, Medtronic, Proprio, and DePuy outside the submitted work. Dr. Park reported royalties and personal fees from Globus; personal fees from Medtronic, DePuy, Accelus, and NuVasive; and grants from Cerapedics, SI Bone, DePuy, ISSG (International Spine Study Group), and SMISS (Society for Minimally Invasive Spine Surgery) outside the submitted work. Dr. Virk reported consulting fees from DePuy, stock from OnPoint, and grants from NIH during the conduct of the study. Dr. Mummaneni reported grants from NREF during the conduct of the study; personal fees from DePuy Synthes, Globus, BK Medical, Brainlab, and SI Bone; grants from ISSG, AO Spine, NIH, PCORI, SLIP II, Pacira, and DoD; stock from Discgenics; and royalties from Springer Publishing and from Thieme Publishers outside the submitted work.

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Supplemental Information

Previous Presentations

This study was presented at the Annual Meeting of the AANS/CNS Section on Disorders of the Spine and Peripheral Nerves (February 21–24, 2024) in Las Vegas, NV, and received the 2024 Journalistic and Academic Neurosurgical Excellence (J. A. N. E.) award. The study was also presented as an oral presentation at the Annual Meeting of the International Society for the Advancement of Spine Surgery (April 26–28, 2024) in Miami, FL. The study was also presented as a poster at the Annual Meeting of the Lumbar Spine Research Society (May 2–3, 2024) in Chicago, IL.

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